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TERMINATION LIABILITY CURVE STUDY(U) ARMY ARMAMENT
MUNITIONS AND CHEMICAL COMMAND DOVER NJ COST ANALYSIS
DIRECTORATE R E AVERS DEC 84 AMSMC-CAR-85-01

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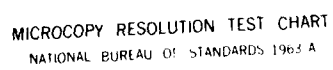
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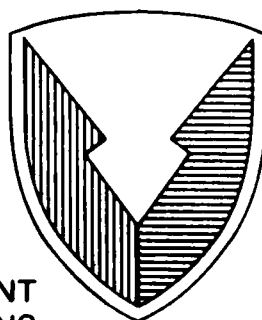
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AD-A153 573

TERMINATION LIABILITY CURVE

STUDY

#85-01



US ARMY
ARMAMENT
MUNITIONS
CHEMICAL COMMAND

Prepared By
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DECEMBER 1984
AMSMC-CAR-S

U.S. ARMY ARMAMENT,
MUNITIONS AND CHEMICAL COMMAND
ROCK ISLAND, ILLINOIS 61299-6000

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ABSTRACT

This study provides the results of analyzing cumulative cost incurred patterns from a cross-section of armament and ammunition orders from Headquarters, Armament, Munitions, and Chemical Command. The study was performed to develop a termination liability curve to cover the costs incurred by the Government in the event of contract cancellation of an order in production. This study represents an update of previous efforts in this area. Particular emphasis was given to items which are known to be common Foreign Military Sales (FMS) items. This document provides composite regression plots for ammunition items and for armament items. Also provided are study assumptions and methodology along with a breakdown of the samples used.

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INTRODUCTION

This study was undertaken to update previous studies done by this division upon the same subject in previous years. Periodic updating is necessary to insure adequate funds are available to cover costs incurred and to pay supplying contractors in a timely manner. The procurement of materials for Foreign Military Sales (FMS) customers is pre-financed as a matter of Army policy. For this reason, the study intentionally focuses on common FMS items.

FMS business has tended to increase over the last several years and the trend seems likely to continue. Periodic updates of the data base are necessary to verify that payment schedule patterns continue to reflect reality. After the Letter of Offer and Acceptance (LOA) has been signed, the customer is billed according to a payment schedule determined by the application of termination liability curves. Customer payments are collected in a centrally controlled customer deposit fund. Army appropriations are then reimbursed from this trust fund.

This study applies only to recurring production costs and not to non-recurring investment costs such as start-up costs, layaway costs, etc. Government furnished material (GFM) is also excluded since it is assumed that such material can be applied to other orders.

PURPOSE

The purpose of this study is to determine the pattern (if any) of cumulative costs incurred with respect to time in terms of percentage of completion. This makes it possible to determine the termination liability or the percentage of contract cost which should be on hand at a given time to cover the costs incurred should the contract be terminated. This study is an update of previous studies conducted by this office.

SCOPE OF THE STUDY

The basis of this study was a selection of 25 samples of various ammunition components and armament end items. Eighteen of the items were ammunition components and the remaining seven were armament end items. These were the end result of a larger sampling which contained samples which proved unsuitable for the purposes of this study. For a more detailed discussion of the procedures used, refer to the section entitled "Methodology".

STUDY RESULTS

AMMUNITION COMPOSITE REGRESSION

SAMPLES: 1-18

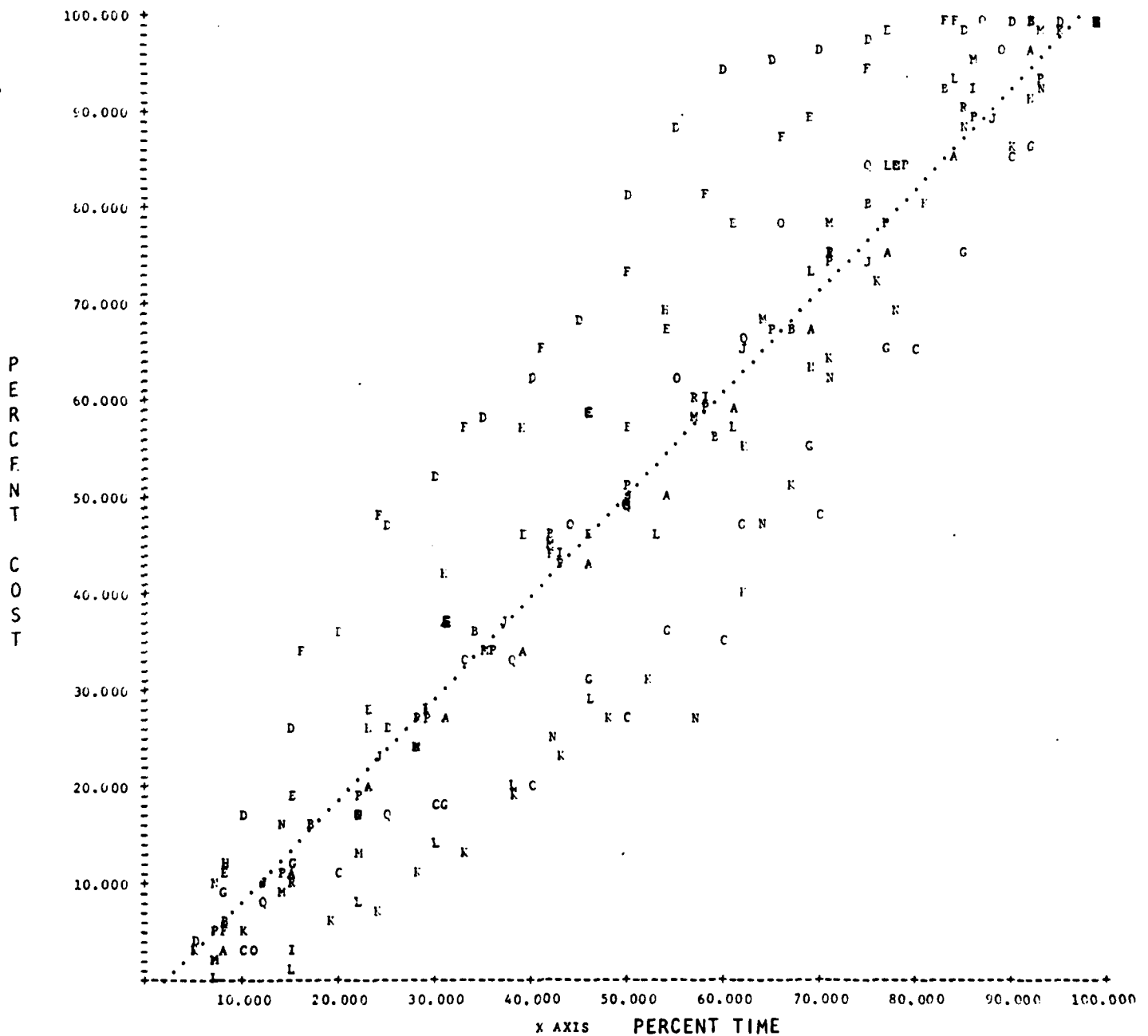
EQUATION: $Y = -2.03441 + 1.05102X$

VARIABLES: Y = PERCENT COST X = PERCENT TIME

COEFFICIENT OF DETERMINATION (R^2) = .8745

T-STATISTIC = 37.89

DEGREES OF FREEDOM = 206



ARMAMENT COMPOSITE REGRESSION

SAMPLES: 19-25

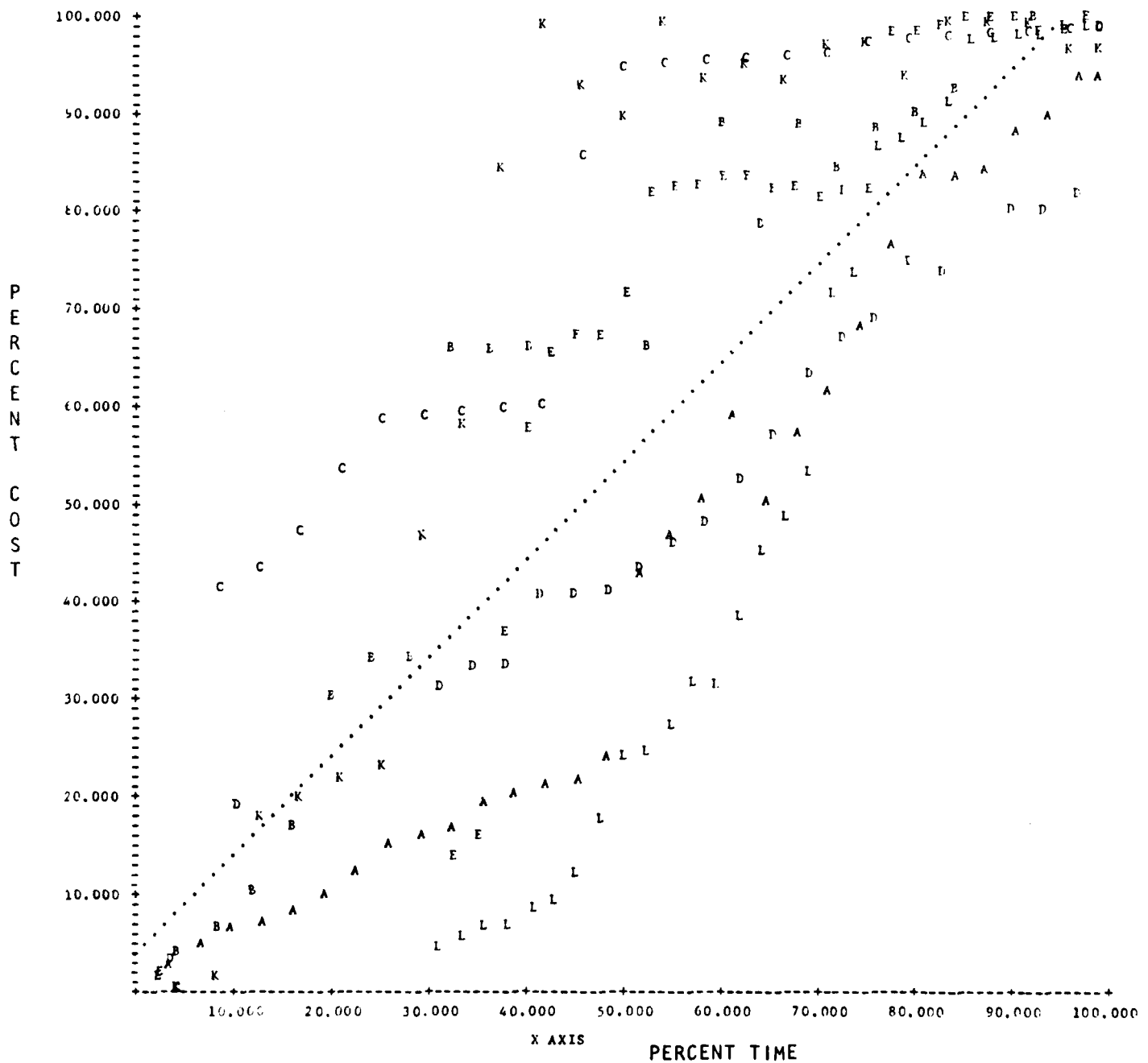
EQUATION: $Y = 4.27416 + 1.00832X$

VARIABLES: Y = PERCENT COST X_2 = PERCENT TIME

COEFFICIENT OF DETERMINATION (R^2) = .6944

T-STATISTIC = 20.28

DEGREES OF FREEDOM = 181



METHODOLOGY

a. Assumptions.

During the course of this study, it was necessary to make several assumptions. The most basic assumption is that the source data obtained accurately reflects the cost incurred patterns of the respective items. Similarly, it was assumed that costs were billed in a timely manner. The above assumptions impact ammunition items and armament items differently, and a more detailed discussion is given in the subsection entitled "Data Collection and Sample Selection", below.

Administrative lead time (the time between order acceptance and the start of production) was initially tracked as part of the study and included in the pattern. However, this proved impractical as identical orders often have radically different lead times. Hence, these lead times were backed out of the samples and all samples are tracked from the start of production until completion.

The study applies only to recurring production costs. Non-recurring investment-type costs should be accommodated separately. No attempt was made to normalize the data due to the effects of inflation over time, nor would it be meaningful to this study to do so. Government furnished materials are excluded since it is assumed that they could be applied elsewhere.

b. Data Collection and Sample Selection.

The samples used fall into two broad classes: Ammunition Components and Armament End Items. The data collection proved to be quite different for these classes and they will be discussed separately.

The source of cost data for all ammunition items was the monthly report Summary of Orders and Cost of Deliveries for the respective ammunition plants (given in the Samples section). All ammunition samples are in the FY 79-FY 83 timeframe. The data collection concentrated on orders with high dollar amounts. Orders below a value of one million dollars tend to be uncharacteristic since they often have erratic production history due to frequent, and often, long-term breaks in production. Samples #1-18 range in dollar value from \$1 million to \$68.2 million. A number of orders which met the dollar criteria were eliminated for various reasons such as erratic production history, order insufficiently complete (at least 90% completion), or incomplete and/or conflicting cost data. In all cases, the production pattern is assumed to follow the disbursement pattern.

The source for armament cost data was the Army Procurement Appropriation Accounting and Reporting System (APARS), which is an automated data base. This system is accessed by Procurement Request Order Number (PRON). There are various levels of PRONs, and the installation-level PRON is used for a detailed breakout of financial transactions. Installation PRONs are issued to component items and must be tracked at that level. A large, complex end item could have hundreds of lower level PRONs assigned. After selecting representative items of armament for cost tracking, these items were screened to eliminate small orders (less than \$1 million). Other samples were further eliminated due to lack of financial history, extremely erratic disbursement patterns, and/or unfinished production.

Once the final sample was selected, lower level PRON cost data (for PRONs exceeding \$100,000) was rolled up into a monthly total end item disbursement pattern. This pattern was compared to the most recent obligation amount to determine degree of order completion. All samples (#19-25) occur in the FY 80-84 timeframe. Dollar values for the samples range from \$2.5 million to \$33.7 million. The production pattern is assumed to follow the disbursement pattern.

c. Data Analysis.

The final selection was comprised of 18 ammunition samples and seven armament samples. A summary of the samples with dollar values is given below:

<u>ITEM</u>	<u># SAMPLES</u>	<u>\$ AMOUNT</u>
Ammunition, Small Arms	7	\$ 41,823,092
Ammunition, Large Caliber	11	253,446,512
AMMO SUBTOTAL	18	\$295,269,604
Armament	7	116,558,556
GRAND TOTAL	25	\$411,828,160

Each sample was initially run through a regression screening program with the independent variable (X) as the percentage of time completion and the dependent variable (Y) as the percentage of cost completion. The screening program performed a Least-Squares Regression on the following forms:

<u>FORM NO.</u>	<u>REGRESSION FORM</u>
1	$Y = A + B * X$
2	$Y = A + B * LN (X)$
3	$LN (Y) = A + B * X$
4	$LN (Y) = LN (A) + B * LN (X)$
5	$\sqrt{Y} = A + B * X$
6	$Y = A + B * X$
7	$\sqrt{Y} = A + B * \sqrt{X}$
8	$Y^2 = A + B * X$
9	$Y^2 = A + B * X^2$
10	$1/Y = A + B * X$

The individual sample regressions were compared to determine which forms predominate. Forms 1, 7, and 4 were commonly the best fits in the given order. After detailed analysis and comparison between the individual samples, composite regressions were run for three categories: small arms ammunition, large caliber ammunition, and armament items. These composite regressions were compared as above to determine form dominance and the results were the same. Comparing the small arms ammunition regression with the large caliber ammunition showed no significant differences. Hence the total composite ammunition regression is used with no distinction made between small arms and large caliber ammunition. The linear model was determined to be the best fit in both cases, ammunition and armament.

d. Conclusions.

The ammunition and armament regressions shown in the previous section entitled Study Results should be used in determination of termination liability costs as a percentage of total order cost with investment type costs applied separately. The pattern of incurred costs represented by these regression equations is tracked down from the start of production through production completion. It is recognized that in FMS cases, the payment schedule is started as the order is finalized and production may not actually start for a considerable period of time. There is no satisfactory way known to eliminate this difficulty and use of these regression equations will cause a front-loading of the FMS payment schedule, particularly in the first 30-40% of the order life. However, this effect decreases in the latter phases of the order life to be nullified at final delivery.

The samples in this study were chosen to reflect a representative sample of FMS-type orders. This reflects total Army production only to the extent that it is representative of the current Army Budget. Thus, care should be taken in applying the results to non-FMS items. Further, from a statistical perspective, the ammunition regression equation is a significantly better fit for the sample data than the armament regression equation. Hence, wider variations can be expected in terms of armament-type items.

One final observation on the study results is applicable. Points at the extreme ends of the data range when plugged into the regression equations could yield results outside of the accepted range of values (e.g., over 100 percent or less than 0 percent). It is recommended that the following corrections be made at the extremes: the ammunition equation should be defined to yield a 1% Y result when X is less than 3%, and Y should be 100% when X is 98% or greater; the armament equation should yield a 100% Y value for $X \geq 95\%$.

AMMUNITION/ARMAMENT SAMPLES

SAMPLE #: 1
PRON: 64-9-A1019
COMPONENT: LAP M483A1 Projectile

TYPE: Ammunition, Large Caliber
CONTRACT #: DAAA09-76-C-4012

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION	
			TIME (X)	COST (Y)
8-31-79	31	1,953,586	8	3
9-30-79	61	7,308,593	15	11
10-31-79	92	13,495,150	23	20
11-30-79	122	18,221,100	31	27
12-31-79	153	23,496,460	39	34
1-31-80	184	29,165,715	46	43
2-29-80	213	34,214,085	54	50
3-31-80	244	39,961,137	61	59
4-30-80	274	45,491,634	69	67
5-31-80	305	51,308,613	77	75
6-30-80	335	58,265,316	84	85
7-31-80	366	65,175,997	92	96
8-31-80	397	68,182,543	100	99

SAMPLE #: 2

PRON: M1-1-A0019

COMPONENT: .50 Cal. Ball M33 Tr., M17, M9 Link

TYPE: Ammunition, Small Arms

CONTRACT #: DAAA09-78-C-3009

<u>MO-DAY-YR</u>	<u>ELAPSED DAYS</u>	<u>CUMULATIVE COSTS</u>	<u>PERCENT COMPLETION TIME (X)</u>	<u>COST (Y)</u>
7-31-81	31	576,657	8	6
8-31-81	62	1,533,269	17	16
9-30-81	92	2,502,200	25	26
10-31-81	123	3,527,792	34	36
11-30-81	153	4,472,677	42	46
12-31-81	184	5,518,804	50	57
1-31-82	215	5,452,374	59	56
2-28-82	243	6,467,821	67	67
3-31-82	274	7,710,637	75	80
4-30-82	304	8,851,373	83	92
5-31-82	335	9,639,453	92	99
6-30-82	365	9,667,065	100	100

SAMPLE #: 3
PRON: U1-1-A0602
COMPONENT: 20 mm TP, M55A2, Bulk

TYPE: Ammunition, Small Arms
CONTRACT #: DAAA09-78-C-3009

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION TIME (X)	COST (Y)
3-31-82	31	35,260	10	3
4-30-82	61	113,753	20	11
5-31-82	92	183,033	30	18
6-30-82	122	206,210	40	20
7-31-82	153	281,325	50	27
8-31-82	184	363,173	60	35
9-30-82	214	499,242	70	48
10-31-82	245	669,553	80	65
11-30-82	275	873,380	90	85
12-31-82	306	1,033,463	100	100

SAMPLE #: 4
 PRON: 64-O-A0016
 COMPONENT: LAP M483A1 Projectile

TYPE: Ammunition, Large Caliber
 CONTRACT #: DAAA09-76-C-4012

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION	
			TIME (X)	COST (Y)
9-30-80	30	2,191,528	5	4
10-31-80	61	9,691,606	10	17
11-30-80	91	14,775,784	15	26
12-31-80	122	20,813,997	20	36
1-31-81	153	26,680,601	25	47
2-28-81	181	30,033,779	30	52
3-31-81	212	32,955,861	35	58
4-30-81	242	35,605,190	40	62
5-31-81	273	38,809,255	45	68
6-30-81	303	42,728,502	50	81
7-31-81	334	46,374,952	55	88
8-31-81	365	50,372,849	60	94
9-30-81	395	53,920,358	65	95
10-31-81	426	54,636,069	70	96
11-30-81	456	55,264,357	75	97
12-31-81	487	55,371,382	80	97
1-31-82	518	55,371,382	85	98
2-28-82	546	56,202,986	90	99
3-31-82	577	57,148,328	95	100
4-30-82	607	57,268,994	100	100

SAMPLE #: 5
PRON: 64-0-A2016
COMPONENT: Projectile, 155mm, M483A1

TYPE: Ammunition, Large Caliber
CONTRACT #: DAAA09-79-C-3001

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION TIME (X)	COST (Y)
5-31-81	31	4,100,312	8	11
6-30-81	61	7,562,440	15	19
7-31-81	92	11,065,233	23	28
8-31-81	123	14,359,675	31	37
9-30-81	153	17,962,914	39	46
10-31-81	184	22,393,857	46	58
11-30-81	214	26,150,754	54	67
12-31-81	245	30,422,875	61	78
1-31-82	276	34,722,652	69	89
2-28-82	304	38,209,343	77	98
11-30-82	334*	38,329,762	84	99
12-31-82	365	38,844,720	92	100
1-31-83	396	38,850,928	100	100

* Adjusted for a period of order inactivity.

SAMPLE #: 6

PRON: M1-1-A2022

COMPONENT: Projectile, 155mm, M483A1

TYPE: Ammunition, Large Caliber

CONTRACT #: DAAA09-79-C-3001

<u>MO-DAY-YR</u>	<u>ELAPSED</u>	<u>CUMULATIVE</u>	<u>PERCENT COMPLETION</u>	
	<u>DAYS</u>	<u>COSTS</u>	<u>TIME (X)</u>	<u>COST (Y)</u>
2-28-82	28	570,177	8	5
3-31-82	59	4,255,959	16	34
4-30-82	89	5,950,616	24	48
5-31-82	120	7,041,269	33	57
6-30-82	150	8,075,692	41	65
7-31-82	181	9,017,567	50	73
8-31-82	212	10,002,436	58	81
9-30-82	242	10,726,872	66	87
10-31-82	273	11,635,812	75	94
11-30-82	303	12,282,372	83	99
1-31-83	365	12,353,954	100	100

SAMPLE #: 7
PRON: 64-O-A4016

TYPE: Ammunition, Large Caliber
CONTRACT #: DAAA09-77-C-4002

COMPONENT: LAP Projectile, 155mm, M483A1

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION	
			TIME (X)	COST (Y)
6-30-81	30	308,139	8	9
7-31-81	61	412,261	15	12
9-30-81	122	651,228	31	18
11-30-81	183	1,090,941	46	31
12-31-81	214	1,290,817	54	36
1-31-82	245	1,656,628	62	47
2-28-82	273	1,961,042	69	55
3-31-82	304	2,310,995	77	65
4-30-82	334	2,676,135	85	75
5-31-82	365	3,040,125	92	86
11-30-82	395*	3,552,295	100	100

* Adjusted for a period of order inactivity

SAMPLE #: 8

TYPE: Ammunition, Small Arms

PRON: M1-1-A0066

CONTRACT #: DAAA09-78-C-3009

COMPONENT: 7.62mm Ball, M80/Tr. M62, M13 Link

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION	
			TIME (X)	COST (Y)
6-30-81	30	748,664	8	12
8-31-81	92	1,639,133	23	26
9-30-81	122	2,610,778	31	42
10-31-81	153	3,541,370	39	57
12-31-81	214	4,282,388	54	69
1-31-82	245	3,420,377	62	55
2-28-82	273	3,893,018	69	63
3-31-82	304	4,821,646	77	78
5-31-82	365	5,650,786	92	91
6-30-82	395	6,202,946	100	100

SAMPLE #: 9
PRON: M1-1-A0102
COMPONENT: 7.62mm Ball, M80, M13 Link

TYPE: Ammunition, Small Arms
CONTRACT #: DAAA09-78-C-3009

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION TIME (X)	COST (Y)
10-31-80	31	104,744	15	3
11-30-80	61	892,655	29	28
12-21-80	92	1,420,039	43	44
1-31-81	123	1,932,239	58	60
2-28-81	151	2,382,644	71	75
3-31-81	182	2,930,920	86	92
4-30-81	213	3,196,589	100	100

SAMPLE #: 10
PRON: 64-0-A0060
COMPONENT: LAP 155mm HERA M549

TYPE: Ammunition, Large Caliber
CONTRACT #: DAAA09-78-C-3008

MO-DAY-YR	ELAPSED	CUMULATIVE	PERCENT COMPLETION	
	DAYS	COSTS	TIME (X)	COST (Y)
2-28-82	28	3,571,243	12	10
3-31-82	59	8,422,360	24	23
4-30-82	89	13,353,674	37	37
5-31-82	120	18,134,795	50	50
6-30-82	150	23,583,872	62	65
7-31-82	181	26,828,982	75	74
8-31-82	212	32,252,371	88	89
9-30-82	242	36,229,419	100	100

SAMPLE #: 11
 PRON: 1A-9-A0177
 COMPONENT: Ctg. 105mm APFSDS-T XM774

TYPE: Ammunition, Large Caliber
 CONTRACT #: DAAA09-77-C-4002

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION TIME (X)	COST (Y)
3-31-80	31	50,119	5	3
8-31-80	62*	91,975	10	5
10-31-80	123	103,870	19	6
2-28-81	151*	119,145	24	7
3-31-81	182	201,140	28	11
4-30-81	212	236,456	33	13
5-31-81	243	335,132	38	19
8-31-81	274*	408,181	43	23
9-30-81	304	476,395	48	27
10-31-81	335	554,134	52	31
12-31-81	366	711,582	62	40
1-31-82	397	906,763	67	51
2-28-82	425	1,130,466	71	64
3-31-82	456	1,284,767	76	72
4-30-82	486	1,418,379	81	80
6-30-82	516	1,531,457	90	86
7-31-82	547	1,732,026	95	98
8-31-82	578	1,774,294	100	100

* Adjusted for periods of order inactivity

SAMPLE #: 12

PRON: M1-8-A0063

COMPONENT: LAP Ctg. 105mm APFSDS-T M735

TYPE: Ammunition, Large Caliber

CONTRACT #: DAAA09-77-C-4002

MO-DAY-YR	ELAPSED	CUMULATIVE	PERCENT COMPLETION	
	DAYS	COSTS	TIME (X)	COST (Y)
2-28-79	28	2,137	7	0.1
6-30-79	58*	21,956	15	1
6-30-81	88*	285,579	22	8
7-31-81	119	483,231	30	14
8-31-81	150	681,414	38	20
9-30-81	180	1,012,200	46	29
10-31-81	211	1,593,988	53	46
3-31-82	242*	2,000,871	61	57
4-30-82	272	2,531,716	69	73
5-31-82	303	2,929,688	77	84
6-30-82	333	3,239,703	84	93
8-31-82	395	3,487,864	100	100

* Adjusted for periods of order inactivity

SAMPLE #: 13
PRON: M1-1-A0013
COMPONENT: LAP Ctg. 105mm TP-T M490

TYPE: Ammunition, Large Caliber
CONTRACT #: DAAA09-77-C-4002

MO-DAY-YR	ELAPSED	CUMULATIVE	PERCENT COMPLETION	
	DAYS	COSTS	TIME (X)	COST (Y)
11-30-81	30	121,984	7	2
12-31-81	61	556,171	14	9
1-31-82	92	808,913	22	13
2-28-82	120	1,465,285	28	24
3-31-82	151	2,072,996	35	34
4-30-82	181	2,745,523	42	45
5-31-82	212	2,998,849	50	49
6-30-82	242	3,527,247	57	58
7-31-82	273	4,164,769	64	68
8-31-82	304	4,749,789	71	78
9-30-82	334	5,152,898	78	84
10-31-82	365	5,819,954	86	95
11-30-82	395	5,987,574	93	98
12-31-82	426	6,123,712	100	100

SAMPLE #: 14
PRON: M1-9-AA088

TYPE: Ammunition, Large Caliber
CONTRACT #: DAAA09-77-C-4002

COMPONENT: LAP Ctg. 105mm HEAT-T 456A1/A2

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION	
			TIME (X)	COST (Y)
11-30-80	30	231,692	7	10
12-31-80	61	382,395	14	16
1-31-81	92	400,253	22	17
2-28-81	120	587,127	28	24
4-30-81	181	613,967	42	25
6-30-81	242	641,392	57	27
6-30-82	272*	1,137,904	64	47
7-31-82	303	1,503,215	71	62
8-31-82	334	1,670,560	78	69
9-30-82	364	2,129,187	85	88
10-31-82	395	2,231,530	93	92
1-31-83	426*	2,419,787	100	100

* Adjusted for periods of order inactivity

SAMPLE #: 15
PRON: F1-2-03198
COMPONENT: Prop. Chg. M119 f/155mm RB

TYPE: Ammunition, Large Caliber
CONTRACT #: DAAA09-78-C-3003

<u>MO-DAY-YR</u>	<u>ELAPSED DAYS</u>	<u>CUMULATIVE COSTS</u>	<u>PERCENT COMPLETION TIME (X)</u>	<u>COST (Y)</u>
1-31-83	31	622,209	11	3
2-28-83	59	3,948,596	22	17
3-31-83	90	7,672,611	33	33
4-30-83	120	10,881,805	44	47
5-31-83	151	14,411,372	55	62
6-30-83	181	17,997,251	66	78
7-31-83	212	19,520,996	78	84
8-31-83	243	22,318,480	89	96
9-30-83	273	23,202,722	100	100

SAMPLE #: 16
 PRON: F1-2-00194
 COMPONENT: 5.56mm Ball M193 Clip

TYPE: Ammunition, Small Arms
 CONTRACT #: DAAA09-78-C-3009

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION	
			TIME (X)	COST (Y)
5-31-82	31	573,689	7	5
6-30-82	61	1,420,360	14	11
7-31-82	92	2,360,962	22	19
8-31-82	123	3,374,424	29	27
9-30-82	153	4,222,976	36	34
10-31-82	184	5,306,404	43	43
11-30-82	214	6,397,425	50	51
12-31-82	245	7,386,846	58	59
1-31-83	276	8,337,209	65	67
2-28-83	304	9,205,243	71	74
3-31-83	335	10,439,561	79	84
4-30-83	365	11,078,741	86	89
5-31-83	396	11,566,774	93	93
6-30-83	426	12,423,385	100	100

SAMPLE #: 17
PRON: WG-0-A0157
COMPONENT: 5.56mm Ball M193 Clip

TYPE: Ammunition, Small Arms
CONTRACT #: DAAA09-78-C-3009

<u>MO-DAY-YR</u>	<u>ELAPSED DAYS</u>	<u>CUMULATIVE COSTS</u>	<u>PERCENT COMPLETION TIME (X)</u>	<u>COST (Y)</u>
6-30-80	30	383,901	12	8
7-31-80	61	825,836	25	17
8-31-80	92	1,618,156	38	33
9-30-80	122	2,348,871	50	49
10-31-80	153	3,215,300	62	66
11-30-80	183	4,042,972	75	84
12-31-80	214	4,831,117	87	99
1-31-81	245	4,841,576	100	100

SAMPLE #: 18
PRON: U1-0-A0190
COMPONENT: 5.56mm Ball M193 Clip

TYPE: Ammunition, Small Arms
CONTRACT #: DAAA09-78-C-3009

<u>MO-DAY-YR</u>	<u>ELAPSED DAYS</u>	<u>CUMULATIVE COSTS</u>	<u>PERCENT COMPLETION TIME (X)</u>	<u>COST (Y)</u>
1-31-81	31	440,895	15	10
2-28-81	59	1,183,807	28	27
3-31-81	90	1,954,072	42	44
4-30-81	120	2,655,714	57	60
5-31-81	151	3,350,498	71	75
6-30-81	181	4,029,933	85	90
7-31-81	212	4,458,068	100	100

SAMPLE #: 19
 END ITEM: M198 Howitzer
 DRC PRON: T1-1-M3844-M101

TYPE: Armament

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION	
			TIME (X)	COST (Y)
12-31-81	31	934,683	3.3	2.8
1-31-82	62	1,696,216	6.6	5.0
2-28-82	90	2,254,280	9.5	6.7
3-31-82	121	2,440,033	12.8	7.2
4-30-82	151	2,844,009	16.0	8.4
5-31-82	182	3,412,805	19.3	10.1
6-30-82	212	4,177,827	22.5	12.4
7-31-82	243	5,141,493	25.8	15.2
8-31-82	274	5,439,850	29.1	16.1
9-30-82	304	5,679,194	32.2	16.8
10-31-82	335	6,550,251	35.5	19.4
11-30-82	365	6,864,226	38.7	20.3
12-31-82	396	7,146,445	42.0	21.2
1-31-83	427	7,315,121	45.3	21.7
2-28-83	455	8,097,384	48.3	24.0
3-31-83	486	14,429,256	51.5	42.8
4-30-83	516	15,784,274	54.7	46.8
5-31-83	547	17,031,286	58.0	50.5
6-30-83	577	19,911,066	61.2	59.0
7-31-83	608	16,966,106	64.5	50.3
8-31-83	639	19,284,777	67.8	57.2
9-30-83	669	20,738,700	70.9	61.5
10-31-83	700	22,962,888	74.2	68.1
11-30-83	730	25,768,292	77.4	76.4
12-31-83	761	28,192,267	80.7	83.6
1-31-84	792	28,139,634	84.0	83.4
2-29-84	821	28,379,006	87.1	84.1
3-31-84	851	29,713,373	90.2	88.1
4-30-84	882	30,256,582	93.5	89.7
5-31-84	913	31,633,413	96.8	93.8
6-30-84	943	31,663,857	100.0	93.8

SAMPLE #: 20
 END ITEM: M85 Machine Gun .50 Cal.
 DRC PRON: WG-1-A0385-M1M5

TYPE: Armament

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION	
			TIME (X)	COST (Y)
12-31-81	31	102,708	4.1	4.1
1-31-82	62	169,697	8.1	6.7
2-28-82	90	260,756	11.8	10.4
3-31-82	121	428,012	15.9	17.0
4-30-82	151	761,739	19.8	30.3
5-31-82	182	858,870	23.9	34.1
6-30-82	213	861,048	28.0	34.2
7-31-82	244	1,654,633	32.1	65.8
8-31-82	275	1,653,691	36.1	65.7
9-30-82	305	1,657,026	40.1	65.9
12-31-82	397	1,660,217	52.2	66.0
2-28-83	456	2,237,284	59.9	88.9
3-31-83	487	1,974,569	64.0	78.5
4-30-83	517	2,232,190	67.9	88.7
5-31-83	547	2,121,213	71.9	84.3
6-30-83	577	2,221,150	75.8	88.3
7-31-83	608	2,264,119	79.9	90.0
8-31-83	639	2,323,058	84.0	92.4
10-31-83	700	2,514,652	92.0	99.9
12-31-83	761	2,514,859	100.0	100.0

SAMPLE #: 21
 END ITEM: M60 Machine Gun 7.62mm LF
 DRC PRON: T1-2-M3700-M101

TYPE: Armament

MO-DAY-YR	ELAPSED	CUMULATIVE	PERCENT COMPLETION	
	DAYS	COSTS	TIME (X)	COST (Y)
7-31-82	31	14,061	4.2	0.3
8-31-82	62	1,978,015	8.5	41.4
9-30-82	92	2,072,374	12.6	43.4
10-31-82	123	2,257,549	16.8	47.2
11-30-82	153	2,588,160	20.9	53.5
12-31-82	184	2,800,965	25.2	58.6
1-31-83	215	2,816,582	29.4	58.9
2-28-83	243	2,831,909	33.2	59.3
3-31-83	274	2,853,280	37.5	59.7
4-30-83	304	2,867,833	41.6	60.0
5-31-83	335	4,086,735	45.8	85.5
6-30-83	365	4,521,965	49.9	94.6
7-31-83	396	4,539,227	54.2	95.0
8-31-83	427	4,554,167	58.4	95.3
9-30-83	457	4,565,239	62.5	95.6
10-31-83	488	4,573,169	66.8	95.7
11-30-83	518	4,586,417	70.9	96.0
12-31-83	549	4,641,569	75.1	97.1
1-31-84	580	4,656,896	79.3	97.5
2-29-84	609	4,675,559	83.3	97.8
3-31-84	640	4,687,033	87.6	98.1
4-30-84	670	4,699,072	91.7	98.3
5-31-84	701	4,709,661	95.9	98.6
6-30-84	731	4,722,089	100.0	98.8

SAMPLE #: 22
 END ITEM: M240 Machine Gun 7.62mm
 DRC PRON: A1-1-03031-M101

TYPE: Armament

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION	
			TIME (X)	COST (Y)
12-31-81	31	338,993	3.5	3.4
2-28-82	90	1,892,741	10.2	19.2
8-31-82	274	3,078,418	31.0	31.2
9-30-82	304	3,289,092	34.4	33.3
10-31-82	335	3,308,145	37.9	33.5
11-30-82	365	4,006,231	41.3	40.6
12-31-82	396	4,021,633	44.8	40.7
1-31-83	427	4,051,866	48.4	41.0
2-28-83	455	4,291,916	51.5	43.4
3-31-83	486	4,539,628	55.0	46.0
4-30-83	516	4,748,003	58.4	48.1
5-31-83	547	5,184,695	61.9	52.5
6-30-83	577	5,627,285	65.3	57.0
7-31-83	608	6,247,364	68.9	63.2
8-31-83	639	6,610,248	72.4	66.9
9-30-83	669	6,799,488	75.8	68.8
10-31-83	700	7,375,939	79.3	74.7
11-30-83	730	7,278,715	82.7	73.7
1-31-84	792	7,916,165	89.7	80.1
2-29-84	822	7,903,007	93.1	80.0
3-31-84	853	8,069,315	96.6	81.7
4-30-84	883	9,878,432	100.0	100.0

SAMPLE #: 23
 END ITEM: M110A2 Howitzer
 DRC PRON: WG-0-M3557-M101

TYPE: Armament

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION	
			TIME (X)	COST (Y)
12-31-80	31	352,456	2.5	2.0
12-31-81	396	2,406,033	32.5	13.9
1-31-82	427	2,767,000	35.0	16.0
2-28-82	459	6,378,017	37.6	36.8
3-31-82	490	9,989,034	40.2	57.6
4-30-82	520	11,318,373	42.6	65.3
5-31-82	551	11,630,042	45.2	67.1
6-30-82	581	11,603,584	47.6	67.0
7-31-82	612	12,365,535	50.2	71.4
8-31-82	643	14,166,412	52.7	81.7
9-30-82	673	14,266,746	55.2	82.3
10-31-82	704	14,275,969	57.7	82.4
11-30-82	734	14,427,426	60.2	83.3
12-31-82	765	14,451,886	62.7	83.4
1-31-83	766	14,227,231	65.2	82.1
2-28-83	824	14,265,547	67.2	82.3
3-31-83	855	14,069,246	70.1	81.2
4-30-83	885	14,193,299	72.5	81.9
5-31-83	916	14,210,300	75.1	82.0
6-30-83	946	17,026,018	77.5	98.2
7-31-83	977	17,038,540	80.1	98.3
8-31-83	1008	17,131,350	82.6	98.9
9-30-83	1038	17,273,776	85.1	99.7
10-31-83	1069	17,277,895	87.6	99.7
11-30-83	1099	17,301,902	90.1	99.8
12-31-83	1130	17,054,518	92.6	98.4
1-31-84	1161	17,076,407	95.2	98.5
2-29-84	1189	17,310,656	97.5	99.9
3-31-84	1220	17,311,952	100.0	99.9

SAMPLE #: 24
 END ITEM: M109A2 Howitzer 155mm
 DRC PRON: WG-2-M3749-M101

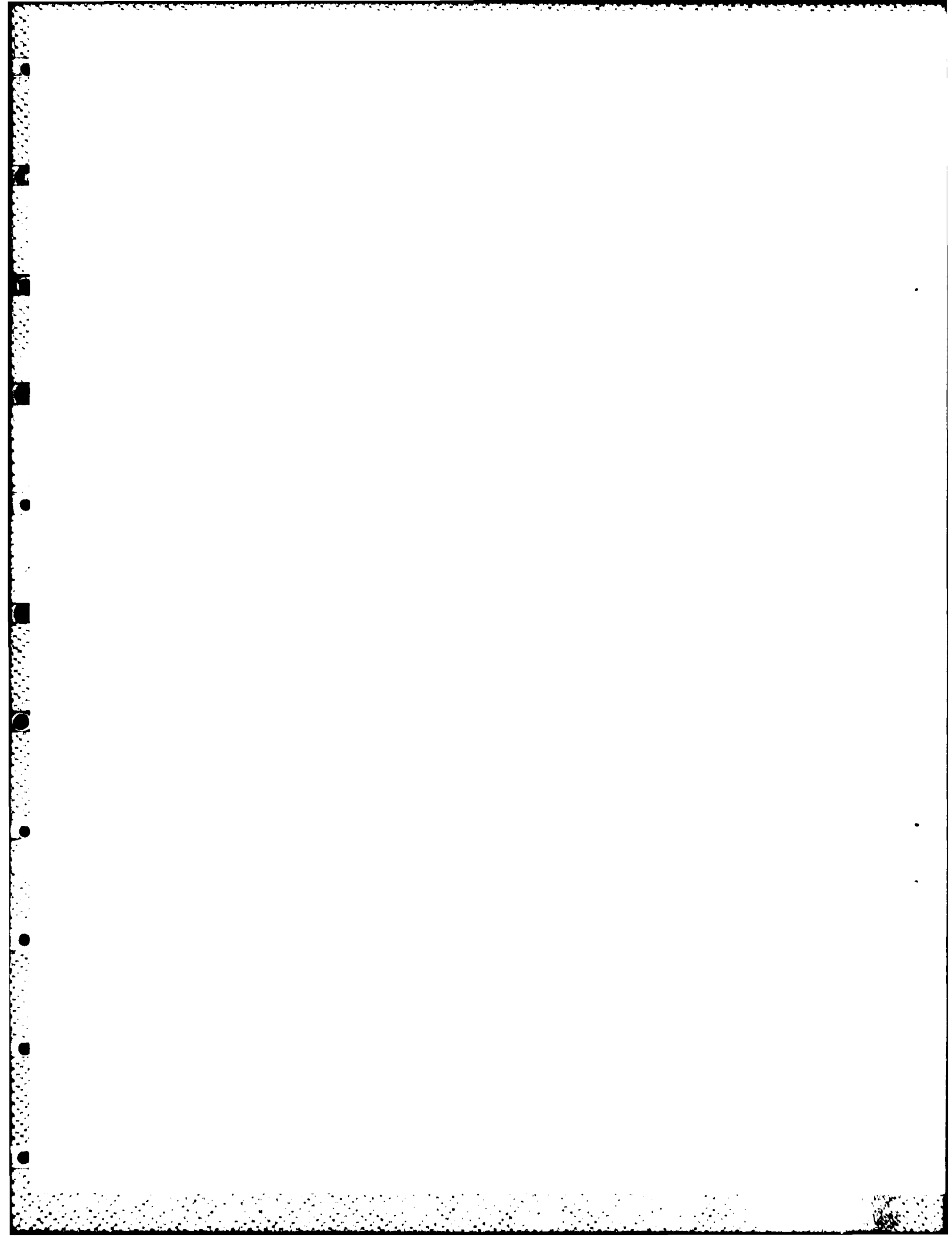
TYPE: Armament

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION	
			TIME (X)	COST (Y)
6-30-82	30	137,635	4.1	0.4
7-31-82	60	490,289	8.2	1.6
8-31-82	91	5,635,869	12.5	17.9
9-30-82	122	6,284,869	16.7	19.9
10-31-82	152	6,865,473	20.8	21.8
11-30-82	183	7,275,473	25.1	23.1
12-31-82	213	14,705,973	29.2	46.7
1-31-83	244	18,289,896	33.4	58.0
2-28-83	272	26,536,310	37.3	84.2
3-31-83	303	31,174,592	41.5	98.9
4-30-83	333	29,206,803	45.6	92.7
5-31-83	364	28,193,444	49.9	89.5
6-30-83	394	31,258,195	54.0	99.2
7-31-83	425	29,439,288	58.2	93.4
8-31-83	455	29,907,582	62.3	94.9
9-31-83	485	29,385,337	66.4	93.2
10-31-83	516	30,528,454	70.7	96.9
11-30-83	546	30,607,023	74.8	97.1
12-31-83	577	29,516,287	79.0	93.7
1-31-84	608	31,306,252	83.3	99.3
2-29-84	637	31,247,775	87.3	99.2
3-31-84	668	31,248,769	91.5	99.2
4-30-84	699	30,424,821	95.8	96.5
5-31-84	730	30,438,171	100.0	96.6

SAMPLE #: 25
 END ITEM: 20mm AD Gun
 DRC PRON: WG-1-M3915-M101

TYPE: Armament

MO-DAY-YR	ELAPSED DAYS	CUMULATIVE COSTS	PERCENT COMPLETION	
			TIME (X)	COST (Y)
12-31-80	31	261,269	2.4	1.6
12-31-81	396	771,179	31.0	4.6
1-31-82	427	960,891	33.4	5.7
2-28-82	455	1,135,476	35.6	6.8
3-31-82	486	1,160,132	38.0	6.9
4-30-82	516	1,449,787	40.4	8.6
5-31-82	547	1,581,031	42.8	9.4
6-30-82	577	2,042,752	45.1	12.2
7-31-82	608	2,975,119	47.6	17.7
8-31-82	639	4,055,933	50.0	24.1
9-30-82	669	4,126,540	52.3	24.6
10-31-82	700	4,585,900	54.8	27.3
11-30-82	730	5,314,158	57.1	31.6
12-31-82	761	5,274,359	59.5	31.4
1-31-83	792	6,444,683	62.0	38.4
2-28-83	820	7,590,343	64.2	45.2
3-31-83	851	8,168,443	66.6	48.6
4-30-83	881	8,940,061	68.9	53.2
5-31-83	912	11,993,482	71.4	71.4
6-30-83	942	12,357,963	73.7	73.5
7-31-83	973	14,522,057	76.1	86.4
8-31-83	1004	14,664,407	78.6	87.3
9-30-83	1034	14,935,188	80.9	88.9
10-31-83	1065	15,306,027	83.3	91.1
11-30-83	1095	16,363,216	85.7	97.4
12-31-83	1126	16,406,455	88.1	97.6
1-31-84	1157	16,470,250	90.5	98.0
2-29-84	1186	16,473,911	92.8	98.0
3-31-84	1217	16,617,666	95.2	98.9
4-30-84	1247	16,619,412	97.6	98.9
5-31-84	1278	16,990,075	100.0	100.0



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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Foreign Military Sales, (FMS) C Termination Liability Curves, Regression Analysis, C		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This study provides the results of analyzing cumulative cost incurred patterns from a cross-section of armament and ammunition orders from Headquarters, Armament, Munitions, and Chemical Command. The study was performed to develop a termination liability curve to cover the costs incurred by the government in the event of contract cancellation of an order in production. This study represents an update of previous efforts in this area. Particular emphasis was given to items which are known to be common Foreign		

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Military Sales (FMS) items. This document provides composite regression plots for ammunition items and for armament items. Also provided are study assumptions and methodology along with a breakdown of the samples used.

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